Table 1-1. Percent of service area in potential mitigation zone

DBS Horizontal Antenna Gain.	dBi	0.0	-3.0	-9.0	-15.0	Total
Maximum RSSi Allowed (C/I = 20 dB)	dBWi	-142.9	-139.9	-133.9	-127.9	
Minimum Separation	km	2.5	1.8	0.9	0.5	
Service Area (uncorrected)	%	2.5%	1.3%	0.3%	0.1%	
Relative Percent of Horizontal Azimuth	%	16.0%	28.0%	42.0%	14.0%	100%
Percent of Service Area Affected	%	0.40%	0.35%	0.13%	0.01%	0.9%

Thus, simply by accounting for azimuth of the DBS antenna, the size of any mitigation zone is decreased dramatically: less than 1% of customers in the service area of a Northpoint transmitter could potentially be affected by interference. A visual representation of the relative sizes of the interference zones and service areas is depicted in Figure 1-4, which shows the relatively small size of any potential 1 km mitigation zone.

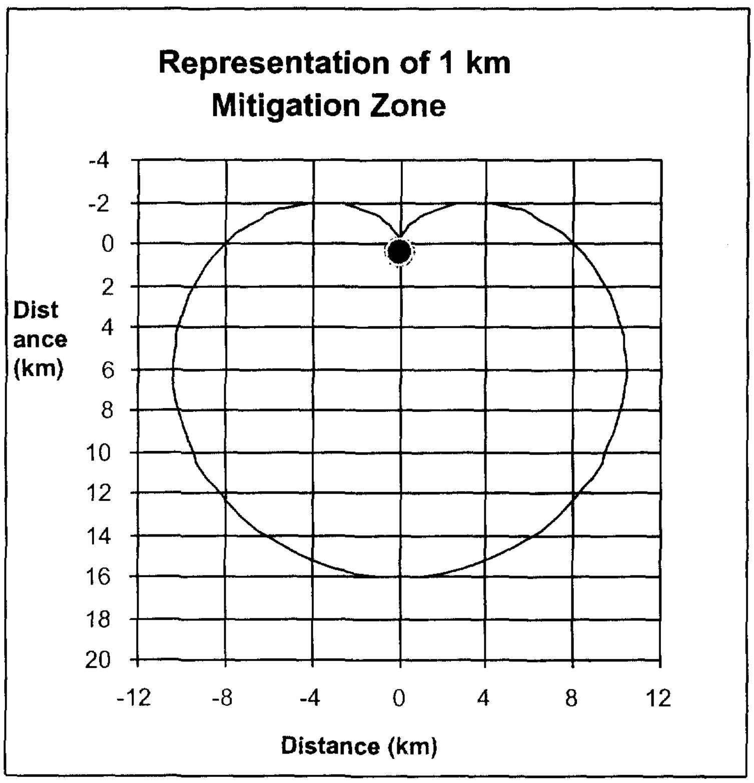

Figure 1-4

Thus, with one simple observation about the horizontal gain pattern of the DBS antenna, it is clear that the only potential effect on DBS receivers DBS is in less than 1.0% of the Northpoint service area. To eliminate interference in this residual area, the Northpoint Technology employs multiple additional interference mitigation techniques, as discussed in Section 2.

Section 2. Interference mitigation through directional broadcast, transmit site selection, vertical plane attenuation, beam tilting and tower height.

The evidence presented in Section 1 demonstrates that DBS antenna rejection will provide a C/I ratio of 20 dB or more in 99 percent of the service area. For the remaining area, Northpoint technology will maintain an RSSi nominally below the suggested DBS interference level through a combination of tower height, vertical plane transmit antenna discrimination and transmission beam tilting/forming techniques.

In Section 1, it was demonstrated that RSSi values below -142.9 dBWi protect all DBS customers. This section will review the following mitigation techniques and show how the RSSi can be maintained below DBS interference levels:

- Directional broadcast from the north;
- Tower height above ground level;
- Vertical plane Northpoint transmitter antenna discrimination;
- Beam tilting of the Northpoint signal;
- Horizontal plane discrimination of the Northpoint signal;
- Placement of the Northpoint transmitter in uninhabited areas; or
- Terrain Blockage.

Additional modification of any affected DBS antenna installations at licensee expense will alleviate any residual interference that would result due to unusual customer antenna placement, off-pointing of the DBS satellite, etc, as discussed in Section 3.

Directional Broadcast: The fundamental characteristic of the Northpoint Technology is the transmission from the north, so as to minimize interference with co-frequency DBS satellite receivers.

Increasing tower height reduces RSSi. Because Northpoint transmitters will be placed on hills, towers or tall buildings, a reduction of the power near the transmitter due to increased path length can be estimated. This is graphically illustrated in figure 2-1. Reduced power levels on the order of 10 dB are seen in the neighborhood of the tower.

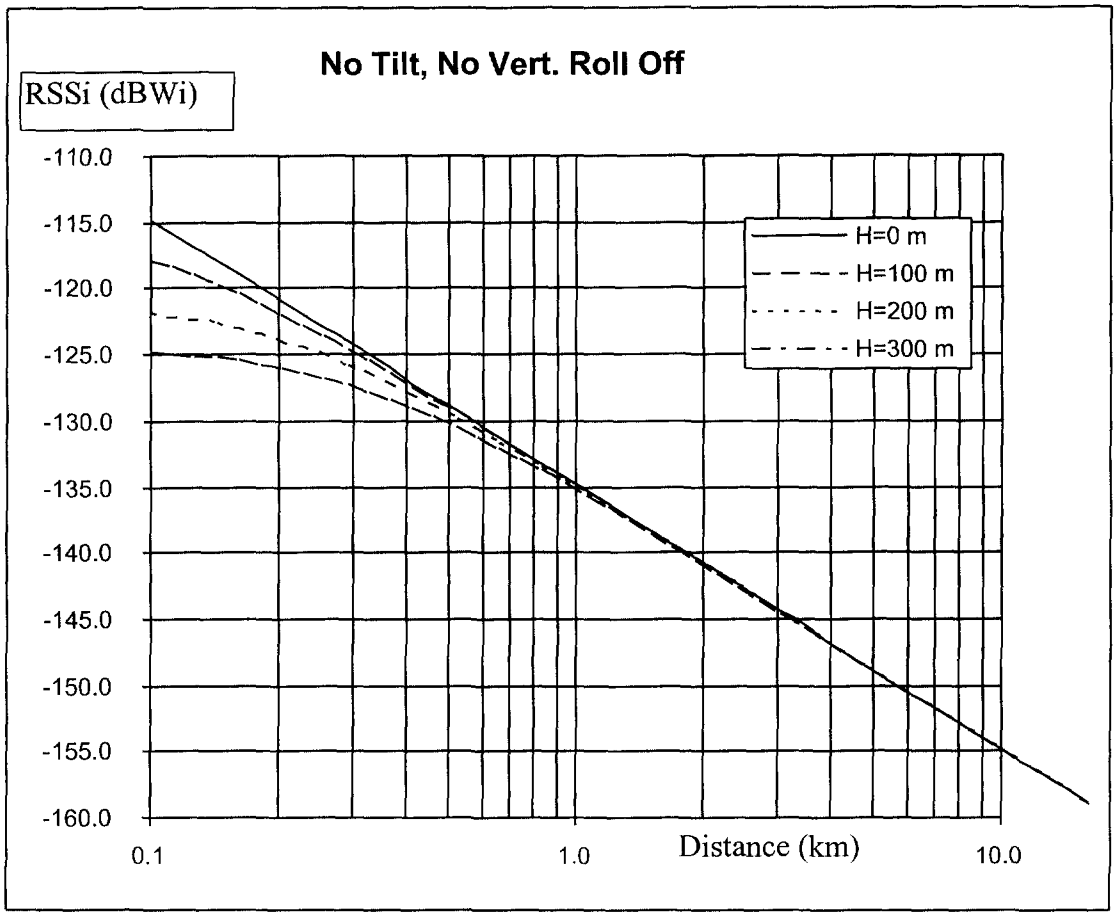

Figure 2-1 RSSi of selected transmitter height above ground level (HAGL)

Discrimination in the vertical plane due to the rapid fall off of the Northpoint transmitter antenna reduces power levels dramatically inside of 3 km. The test antenna used in the Northpoint experiment has a half-power single sided beam width of 9°. A model of the antenna pattern is presented in the DeLawder engineering attachment.

Figure 2-2 demonstrates the power levels for transmitters at various heights above ground level taking into account the vertical antenna pattern. A dramatic reduction in RSSi is seen when this effect is taken into account. The line at -142.9 dBWi shows where the entire DBS service will be fully protected with a 20 dB C/I ratio. With a 200 meter tower installation, only 4 dB of additional attenuation is required to reach this level. Thus, the entire service area is protected to at least a 16 dB C/I ratio, an acceptable level in many circumstances. At this level, there is only the potential for interference to less than 0.5% of the DBS subscribers.

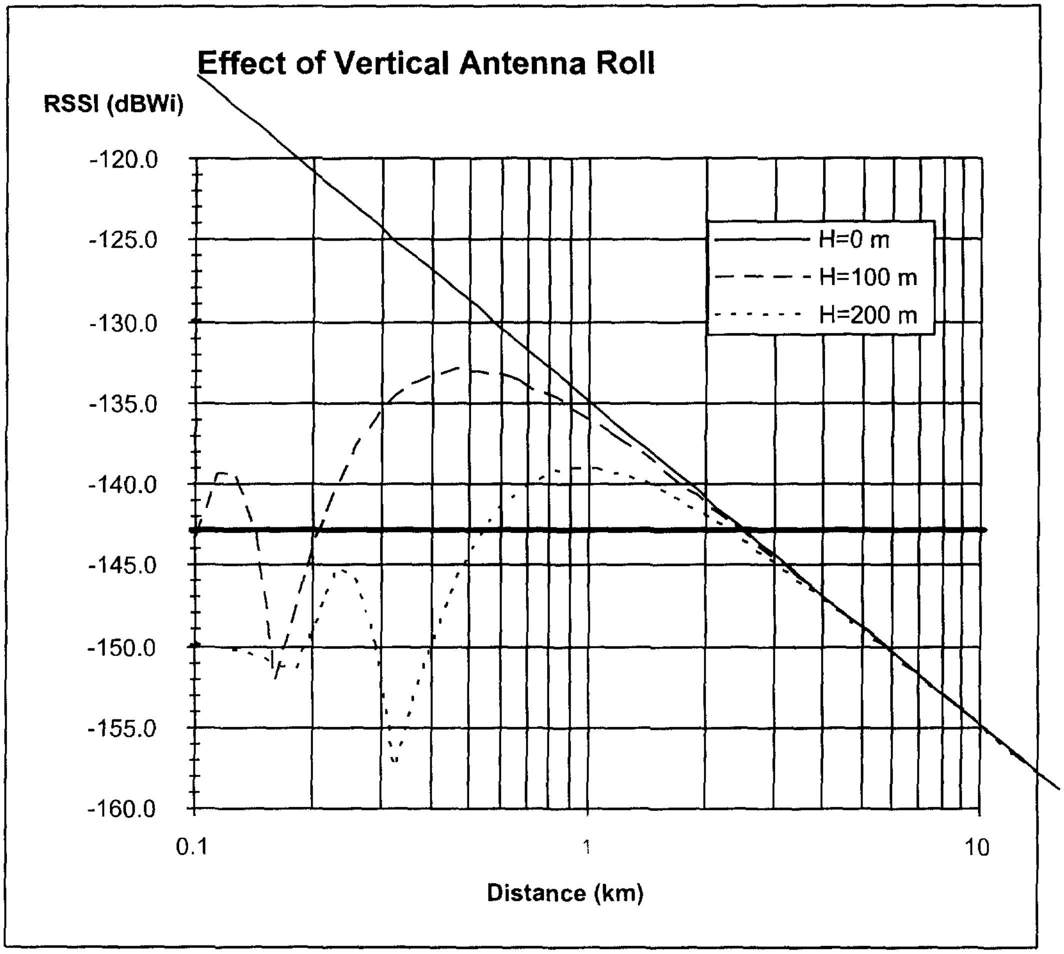

Figure 2-2. Effect of Vertical Plane Antenna Discrimination.

Although the described antenna was employed in experimental testing, the shape of the beam can be improved upon for commercial deployment. Additional beam forming in the vertical plane is also possible beyond that employed in this analysis.

Beam Tilting of the Northpoint Signal. In addition to vertical plane attenuation, Northpoint plans to employ beam tilting to further reduce RSSi levels in the mitigation zone when necessary. As discussed below, a vertical tilt of up to 5 degrees results in a reduction of only 1 dB RSSi at the maximum service distance of 16 km, within the design margin of the Northpoint system while providing additional attenuation in the mitigation zone. Figure 2-3 shows the added effect of beam tilting for a typical Northpoint transmitter height of 150 meters.

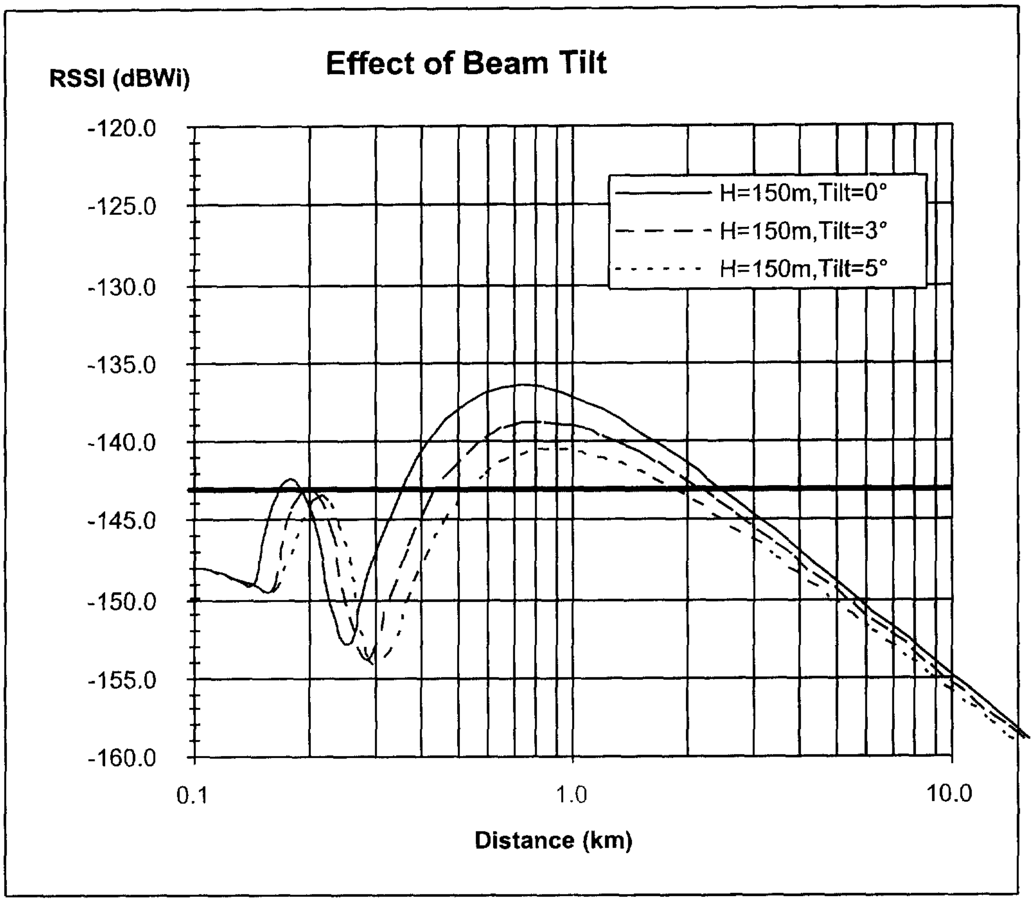

Figure 2-3. Effect of Beam Tilting.

The line at -142.9 dBWi shows where all DBS customers will be fully protected. In this analysis, which considers a 150 meter installation and 5 degrees of beam tilt, only three dB of additional attenuation would be needed to reach the level where all customers will be protected at a C/I of 20 dB. All DBS customers are protected to a level of 17 dB C/I ratio. At this level, there is only the potential for interference to less than 0.25% of DBS subscribers.

A combination of these mitigation techniques will protect all DBS customers. The RSSi for a Northpoint antenna at 200 meters with 5 degrees of tilt is shown as Figure 2-4. As can be seen, the cumulative effects of these mitigation techniques has a dramatic impact on the size of the mitigation zone. In this example, *all* DBS subscribers will be protected at a C/I ratio of 20 dB or better. Figure 2-4 illustrates the corresponding C/I values for various DBS antenna rejection levels.

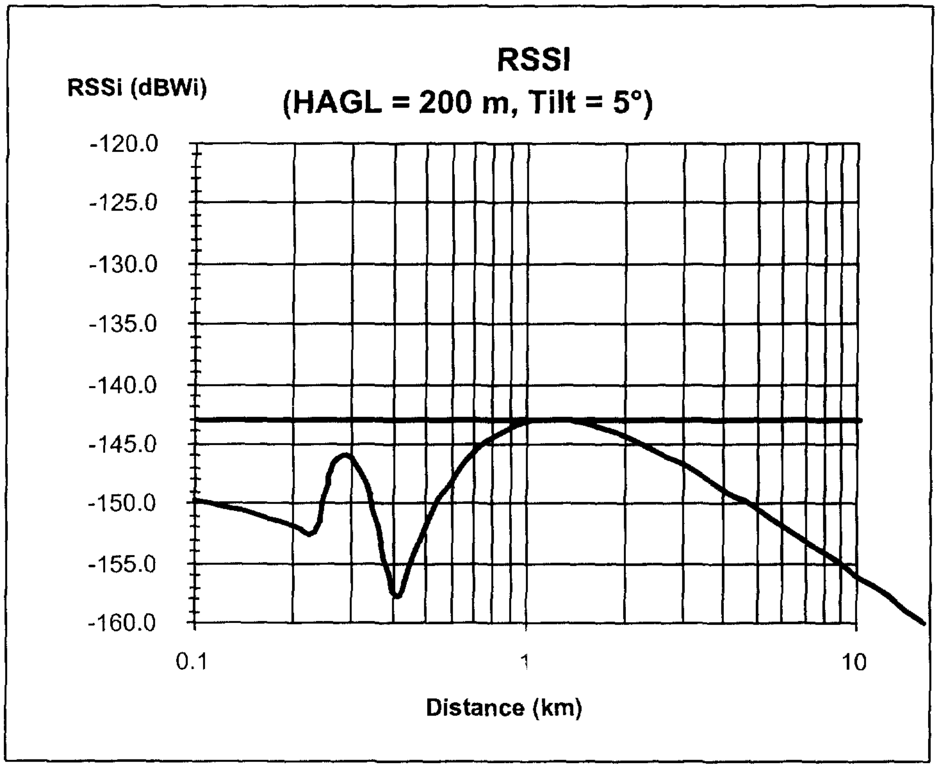

Figure 2-4. Combination of Effects.

Figure 2-5 shows that the entire service area will be protected at a C/I level greater than 20 dB, and the majority will have protection ratios in excess of 30 dB.

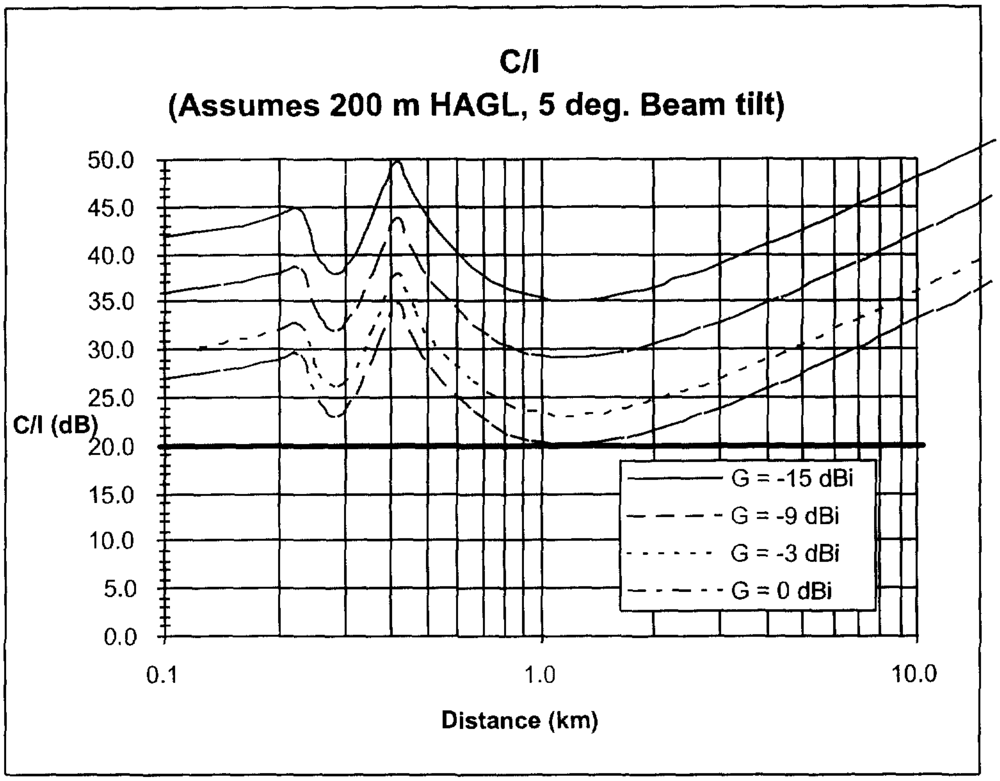

Figure 2-5

The horizontal plane discrimination of the Northpoint signal. The analysis above does not even take into account variations that exist in two dimensions, such as the effects of horizontal attenuation of the Northpoint transmitter and variations in the respective satellite positions of the DBS systems. In order to provide an accurate two dimensional representation, a series of plots were developed by DeLawder Communications, Inc. using EDX Engineering, Inc.'s **MSITE™** (version 3.0) commercial computer software program. This software was used in studies accounting for both vertical and horizontal plane antenna discrimination for the Northpoint transmit antenna and the DBS receive antenna in the determination of C/I ratio values. This work is attached as "Engineering Exhibit prepared by DeLawder Communications, Inc."

Potential interference in Austin, Texas. For a typical Northpoint installation in Austin Texas, interference C/I ratios were calculated for several DBS look angles to the GSO arc, using actual DBS satellites in operation. Because the software used to generate these figures also accounts for the horizontal discrimination of the Northpoint transmitter (using the antenna pattern in the attachment), the analysis yields a much more accurate representation of the potential mitigation area. In many cases, the combination of effects has virtually eliminated the mitigation zone.

Note that the actual antenna pattern used, both in testing and in the EDX analysis, is slightly less powerful in the side and back lobes than a standard cardiod. The corresponding service and potential mitigation areas are smaller. The service area of the antenna tested is 240 km^2, 20% smaller than the analysis presented herein.

Terrain Blockage. It is important to note that in any mitigation zone that might exist, attenuation due to terrestrial blockage will also contribute in reducing interference.[5] Importantly, a significant percentage of DBS installations are below the roof line. The antenna manufacturer, as well as DBS receiver manufacturers Sony and RCA, recommend roof-top installations only as a last resort. Attenuation due to terrestrial blockage will also protect a significant percentage of DBS users. If one assumes, conservatively, that only half (50%) of the possible installations in the mitigation zone are below roof top (lack of line of sight), this further reduces the number of affected DBS subscribers in any mitigation zone.

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[5] DIRECTV agrees that "Natural shielding will occur and reduce interference levels, but cannot be counted upon" Terrestrial Interference in the DBS Downlink Band op. cit. p 23. Northpoint agrees and asserts that where natural shielding does not protect DBS consumers Northpoint will employ other mitigation techniques to alleviate interference.

Section 3. Residual interference mitigation techniques.

The foregoing sections demonstrate that the Northpoint system will not interfere with DBS receivers. In the unlikely event that it does, the licensee will bear the burden of preventing interference to the few users affected. Specifically, the licensee will modify, upgrade or otherwise protect any affected DBS customer, at its own expense. The techniques employed in these cases include:

- Repositioning poorly pointed DBS antennas to eliminate pointing losses;
- Replacing the standard DBS antenna with one with better rejection characteristics;
- Relocating DBS subscriber receivers away from line-of-sight.
- Shielding to protect DBS customers.

The use of these techniques can add several dB of additional margin.

Section 4. Improvement of conservative assumptions.

In the prior sections, Northpoint has demonstrated that the potential mitigation zone where interference into DBS receivers might be a concern are quite small, and may in fact not interfere. This section notes that the interference analysis was generated using DBS industry-supplied conservative figures. In actual fact, real-world interference is likely to be less. This should provide the Commission, and the DBS industry, with an extra margin of comfort with Northpoint's technology.

The interference targets on which Northpoint based its analysis could be improved upon in an open industry dialog. Northpoint would welcome such discussions. For example, there is room for improvement in the C/I figure of 20 dB. Additionally, in many parts of the country, the clear sky C/N value for DBS receivers will be higher than 11.4 dB. To the extent this is true, a C/I figure lower than 20 dB would still ensure high-quality reception by DBS users.

Improvements in the C/I ratio. In the baseline interference budget, a value of C/I of 20 dB was used. Each 3 dB improvement reduces the potentially affected service area by 50% or more. Two respondents, Tempo and Echostar, indicated that C/I ratios of 19 - 20 dB, or greater, would be necessary to facilitate sharing. With the advent of digital technology, interference ratios of better than 20 dB can be demonstrated not to cause signal degradation, if only because interference between digital carriers normally is less severe than between analog carriers.

Carrier Offsets. Moreover, it is possible to reduce interference through carrier offsets. ITU-R Study Group 11 document 11/93(Rev 1.), 23 May 1997, Draft New Recommendation ITU-R BO.[EEE/11], Protection Masks and Associated Calculation Methods for interference into Broadcast Satellite Systems Involving Digital Emissions, approved in the last Radiocommunication Assembly, demonstrates that offset carriers can result in significant reductions to the effective C/I ratio. In the example cited in ITU-R-11/93, an offset of 7 MHz would yield about a 2-4 dB reduction in interference. With the Northpoint technology, a 7 MHz horizontally polarized carrier offset is possible to both left and right circular DBS polarizations. However, for the purposes of the foregoing analysis, these effects have not been accounted for; further analysis would yield more favorable sharing criteria.

Higher DBS Clear Sky ratio. A 20 dB C/I value relies upon the C/N value of 11.4 dB cited by DIRECTV on page 5 of its report to the Commission as a typical DIRECTV link budget value. However, as the FCC well knows, the typical value for DBS C/N used in the baseline interference budget will vary depending on: (1) where the user is, in relation to boresight and edge of beam; and (2) the actual value of the clear sky C/N where the user is located. ITU-R 4-9-11/46, shows current typical edge-of-coverage EIRP values in operation in Region 2 between 48 and 52 dBW, which yield edge of coverage clear sky C/N values between 11 and 15 dB. If edge of coverage is 3 dB down from peak, the corresponding clear sky boresight C/N values would be between 14 and 17 dB, and the C/I of the Northpoint system could be 3-7 dB lower.

DBS C/I protection values cited by respondents. Various respondents proposed a variety of C/I values. Both Tempo and EchoStar indicated a C/I of around 20 dB or greater would be sufficient; some provided no such value, see Table 4-1.

Table 4-1. System and Protection Ratios, figures in dB.

Respondent	C/N required	C/N (Clear Air)	C/I	I/N
USSB	-	-	-	-
EchoStar	-	-	20	-
Tempo	8	-	19	-
PrimeStar	-	-	-	-
DIRECTV	-	11.4	34.4	-23

Northpoint's planned series of experimental tests will refine these numbers, and Northpoint looks forward to working with the DBS industry to reach an agreement on sharing criteria.

Relevant Sources of Protection Criteria. Northpoint also notes that some DBS proponents have provided various suggested protection criteria designed to address interference from sources that bear little relation to Northpoint's proposed fixed and broadcast services. For example, DIRECTV cites a working document in ITU-R JTG 4-9-11 as a source for an I/N of -23 dB derived from ITU-R Appendix 30. This figure was developed to further refine EPFD levels for protection of the BSS from NGSO-FSS systems. Without commenting on the required protection ratios between NGSO-FSS systems and the BSS, Northpoint notes that there are fundamental technical and operational differences between NGSO-FSS systems and the Northpoint FS (point-to-multipoint) or BS systems. These fundamental differences call for different approaches in establishing interference protection ratios. NGSO-FSS systems employ low-orbiting satellites which produce dynamically varying interference power levels, potentially into the main lobe of BSS systems, while terrestrial Northpoint systems will employ fixed EIRP with interference mitigation techniques that will only be received at the BSS backlobe levels.

Relevance of ITU Protection Criteria. Other protection ratios cited in the comments and in ITU-R appendix 30 were developed based upon other inapplicable assumptions:

- The C/I protection ratios were used with the MSPACE interference analysis software to develop the Regional assignment plans for the BSS, using the reference system parameters for typical BSS systems.

- The Plan assumes that ALL BSS assignments throughout the Region have been implemented using exactly those reference parameters, and calculates aggregate interference based upon this assumption.

However, as noted by DIRECTV in ITU-R JTG 4-9-11/46, "it is totally unrealistic to use the reference system parameters that were used for planning fifteen, or even one year ago" and "BSS systems utilize satellite EIRPs lower than the Plans (e.g., 53 dBW vs 60 dBW or more)."[6] In addition, the Plans are not fully populated, or even 20% populated, and the actual EIRP's are 7 dB or more below reference system values used to develop for intra- (and inter) system protection ratios. The actual intra-service interference levels will be far below levels already allocated for in BSS system interference budgets.

Another inappropriate assumption was that existing ITU protection ratios were developed to protect analog BSS transmissions from analog interference sources. For the digital transmission in use by all BSS systems in the planned band and proposed for use by Northpoint, the protection ratio will be several dB lower than that used to develop the Region 2 BSS plan in 1983. Note that when Regions 1 and 3 adopted a revised plan at WRC-97, the protection ratio was reduced by more than 7 dB.

These assumptions fail to take into account that in the domestic environment, users of the spectrum, and thus interference levels, can be controlled to a much greater degree than the assumptions ITU-R reference levels were based upon. For example, at 12.2 - 12.7 GHz there are international allocations for the terrestrial BROADCAST, FIXED and MOBILE services, as well as the BSS and NGSO-FSS services, whereas domestically, there are currently no allocations to the BS, MS or FSS services. U.S. BSS providers can thus expect far greater protection from interference simply due to the relative scarcity of co-frequency systems.

Thus, in sum, the differences between the interference environment assumed in AP 30/30A and the actual environment in the U.S. with today's digital technology , seriously calls into question the application of ITU-R inter-service and intra-service protection ratios in the domestic arena.

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[6] JTG 49-9-11/46, page 2

Section 5 - Conclusion

This appendix has demonstrated that the Northpoint Technology can share the 12.2 - 12.7 GHz band with DBS systems. Even based on preliminary analysis, Northpoint will provide an adequate C/I ratio to more than 99 percent of the DBS subscribers in its service area, taking into account the lower gain of DBS receivers off-azimuth. However, Northpoint Technology employs directional broadcast techniques to reduce and ultimately even eliminate the mitigation zone. Moreover, Northpoint licensees will be able to use several techniques to ensure that non-typical installations are also not adversely affected. Northpoint looks forward to working with the DBS industry, including in its upcoming second phase of experimental testing, to ensure that accurate protection ratio numbers are utilized.

Appendices: Link budgets and sample calculations.

These appendices provide reference data for the foregoing conclusions about sharing in the 12.2-12.7 GHz band.

Table A-1. Northpoint Technology Sample Link Budget.

Line	Units	Source/Calculation	Item	Symbol	Value
1	MHz		Channel Bandwidth	B	24.0
2	GHz		Frequency	f	12.5
3	%		Availability		99.7%
4	dBW		Transmit Power	P	-25.0
5	Watts		Transmit Power	p	0.003
6	dB		Line Losses	Ll	-2.5
7	dBi		Transmit Gain	Gt	10.0
8	**dBW**	**P+Ll+Gt**	**EIRP**	**EIRP**	**-17.5**
9	dBm		EIRP (dBm)	EIRPdBm	12.5
10	km		Path Length	D	16.0
11	dB	-114.3-20*log(D)	Path Loss	Pl	-138.4
12	dB		Fade Margin	Fm	-2.0
13	dB		Atmos	Atmos	-0.1
14	dB		Rain Margin	Rain	-1.5
15	**dBW**	EIRP+Pl+Fm+Atmos+Rain	**RSSi**	**RSSI**	**-159.5**
16	dBm		Isotropic RSS (dBm)	RSSI dBm	-129.5
17	dBi	45 cm antenna	Receive Antenna Gain	G	34.0
18	dB		Pointing Loss	Ploss	-0.5
19	dBW	RSSI+G+Ploss	C Received	Crec	-126.0
20					
21	°K		System Temp	t	120.0
22	dB-°K	10*log(t)	System Temp	T	20.8
23	dB/K	G-10*log(T)	G/T	G/T	13.2
24	dB/K	Constant	Boltzmans	k	-228.6
25	dB	k+10*log(TB*10e6)	Noise Figure kTB	N	-134.0
26					
27	dB	C-N	Theoretical C/N Received	C/N	8.0
28	dB	QPSK at 10e-04 BER	C/N Required	C/Nreq	8.0
29	dB	C/N-C/Nreq	System Margin	Margin	0.0

Line 1 — Channel Bandwidth. Northpoint has options of employing various channel bandwidths between 1 and 24 MHz. The channel bandwidth of 24 MHz represents a worst case for interference calculations. For example, three 8 MHz carriers would required the same power as one 24 MHz carrier, and the power in the 24 MHz DBS noise bandwidth would be equal

Line 2 — Frequency, center frequency of the 12.2 - 12.7 GHz band.

Line 3 — Availability is based on outage values of about 26 hours per year.

Lines 4-5 Power of -25 dBW sufficient to close the link.

Lines 7-9 While higher or lower transmit gains or EIRP's may be employed in individual applications, the RSS levels will remain nominally below interference levels through the variety of techniques stated in the text.

Line 10 Service distance on boresight.

Line 12 2 dB of Fade margin.

Line 13 0.1 dB of atmospheric attenuation is identified for oxygen and water vapor absorption as a seasonal and typical height above mean sea level average.

Line 14 ITU-R PN.530-5, Rain Zone E, see sample calculation in Table A-3 below.

Line 17 A nominal gain of 34 dBi is used. Higher gain antennas may be employed in different rain regions or specific applications.

Line 28 A nominal C/N requirement of 8.0 is used in the system design. Because Northpoint will employ the same subscriber equipment for downconverting and decoding as the DBS industry, C/N values between 5 and 8 dB can be used. These levels were also verified through testing.

Based on the foregoing, Northpoint has developed its preliminary interference budget.

Table A-2. Preliminary Interference Budget.

Line	Units	Calculation	Item	Symbol	Value
1	GHz		Frequency	f	12.5
2	dB		DBS Clear Sky C/N	C/N	11.4
3	dB/K		DBS G/T	G/T	13.0
4	dBi	45 cm dish	DBS G	G	34.0
5	°K	10^((G-G/T)/10)	DBS T	T	125.9
6	MHz	DBS Noise Bandwidth	DBS B	B	24.0
7	dBW		DBS Noise Figure	N	-133.8
8	dB		Pointing Loss	Ploss	-0.5
9	dBW	C/N+N+Ploss	DBS C received	Crec	-122.9
10	dB		DBS C/I Allow	C/I	20.0
11	dBW	Crec-C/I	Allowable Interference	I	-142.9
12					
13	dBi	Note 2	DBS Antenna Gain towards Horizon	Gain	0.0
14	dBW	I-Gain	Allowable RSSI	RSSI	-142.9

Line	Units	Calculation	Item	Symbol	Value
15	dBW		Interferer EIRP	EIRP	-17.5
16	dB	RSSI-EIRP	Required Attenuation	PLreq	125.4
17	dB		Polarization Isolation	PolIso	-3.0
18	km		Tower Height	HAGL	0
19	deg		Beam Tilting	Beam	0
20	km		Ground Separation Distance	D	2.532
21	km		Total Path	Dtot	2.5
22	dB		Path Loss	PathLoss	-122.4
23	deg		NP Xmit Angle	theta	0.0
24	deg		Xmit Ant. Discrim	XmitDis	0.0
25					
26	dBWi		RSSI	RSSI	-142.9
27	dBWi		RSSI Allowed	Allowed	-142.9
28	dB		Margin		0.0

Line 2. DBS Clear Sky C/N. The value of 11.4 dB was cited in opposition of DIRECTV on page 5 as a typical DIRECTV link budget C/N value. ITU-R 4-9-11/46, shows current typical edge-of-coverage EIRP values in operation in Region 2 between 48 and 52 dBW, which yield edge of coverage clear sky C/N values between 11 and 15 dB. If edge of coverage is 3 dB down from peak, the corresponding clear sky boresight C/N values would be between 14 and 17 dB.

Line 2/3 Typical G/T and antenna gain values are also found in ITU-R 4-9-11/46 and elsewhere.

Line 7 DBS Noise. Figure derived from the relationship N=kTB.

Line 8 Pointing loss. an accounting of 0.5 dB is made for pointing loss. Some respondents argued that pointing losses of 3 dB are required, however Northpoint asserts it can re-point any such poorly pointed DBS antenna.

Line 10 C/I. Two respondents cited C/I ratios of greater than or equal to 19-20 dB. Northpoint asserts that lower C/I values will not cause significant degradation in overall C/I+N. Advances in digital technology continue to refine what is and is not interference. For example, reference ITU-R Study Group 11 document 11/93(Rev 1.), 23 May 1997, Draft New Recommendation ITU-R BO.[EEE/11], Protection Masks and Associated Calculation Methods for interference into Broadcast Satellite Systems Involving Digital Emissions, approved in the last Radiocommunication Assembly. This document demonstrates that for offset carriers significant reductions to the effective C/I ratio can be taken. In the example cited in ITU-R-11/93, an offset of 7 MHz would yield about a 2-4 dB reduction.

With the Northpoint technology, a 7 MHz horizontally polarized carrier offset is possible to both left and right circular DBS polarizations. However, for the purposes of this analysis, these effects have not been accounted for, thus further analysis would yield more favorable sharing criteria.

Line 13 DBS Gain towards horizon. For the purposes of this first look interference budget, a gain of 0 dBi is used. For nearly all azimuthal directions, the gain of the DBS antenna in the horizontal is lower, as much as 16 dBi lower, further reducing potential interference.

Line 14 Interferer EIRP value is taken as typical, lower or higher EIRP values would yield closer or farther separation distances.

Line 17 A polarization isolation of 3 dB was taken. Northpoint uses horizontal or vertical polarization, and DBS is circularly polarized. Half of the Northpoint power would be seen in either polarization.

Lines 18 - 19 The Northpoint transmitter height above ground level and Beam Tilting both are zero in the example, but are used in the calculation of Northpoint antenna discrimination in line 24 and Total Path in line 21.

Line 20 The required maximum ground separation distance was calculated as follows:

RSSI Allowed -EIRP-XmitDis-PolIso=PathLoss

The required path loss in the example:

-142.9-(-17.5)-0-0=-114.33-20*log(D)

Solving for D yields 2.532 km.

Line 21. Total path = (D^2+HAGL^2)^(0.5)

Line 23 theta = arctangent(HAGL/D)

Line 24 XmitDis = F(theta + Beam) according to the envelope provided in the attachment.

Line 26 - 28 Used to verify the RSSI is at or below the allowed level, and the margin is calculated.

This following table is intended to respond to comments by Tempo that over 10 dB of rain margin is required for the Northpoint system. As Table A-3 shows, the six step Calculation Method of ITU-R Rec PN.530-5, yields a required rain margin of only 1.6 dB.

Table A-3
(Assumptions, 20° C Rain Temperature, 12 GHz)

Line	Item	Symbol	Value	Units
1	Step 1	a	0.0168	
2		b	1.200	
3	Step 2	Rain Region	E	
4		R	22.000	mm/hr
5	Step 3	A	0.686	
6	Step 4	d	16.000	km
7		do	25.162	km
8		r	0.611	
9	Step 5	A 0.01%	6.708	
10	Step 6	A 1.0%	0.805	dB
11		A 0.1%	2.616	dB
12		A 0.2%	1.847	dB
13		A 0.3%	1.512	dB

BOB COMBS & ASSOCIATES
TELECOMMUNICATIONS ENGINEERING

PO BOX 3089, FALLS CHURCH VA 22043 TEL: (703)288-5123
FAX: (703)288-5124

CERTIFICATION

1. My name is Robert Combs and I am president of BCA International, an engineering services firm.

2. I have an ME in Systems Engineering from the University of Virginia, 1992; and a BS in Aerospace Engineering (Cum Laude) from the University of Texas (Austin), 1986.

3. I hereby certify that I am the technically qualified person responsible for the preparation of the Technical Annex to Reply Comments of Northpoint Technology.

4. The Annex, and the technical information in the Reply Comments, are complete and accurate to the best of my knowledge.

Dated: May 5, 1998

Robert Combs

DELAWDER COMMUNICATIONS, INC.
TELECOMMUNICATIONS CONSULTANTS
5568 GENERAL WASHINGTON DRIVE • SUITE A218 • ALEXANDRIA, VIRGINIA 22312
(703) 658-5390
(703) 658-5394 TELECOPIER

DARRYL K. DELAWDER, *PRESIDENT*
DAVID R. MIETUS, *VICE PRESIDENT*

ENGINEERING EXHIBIT PREPARED BY

DELAWDER COMMUNICATIONS, INC.

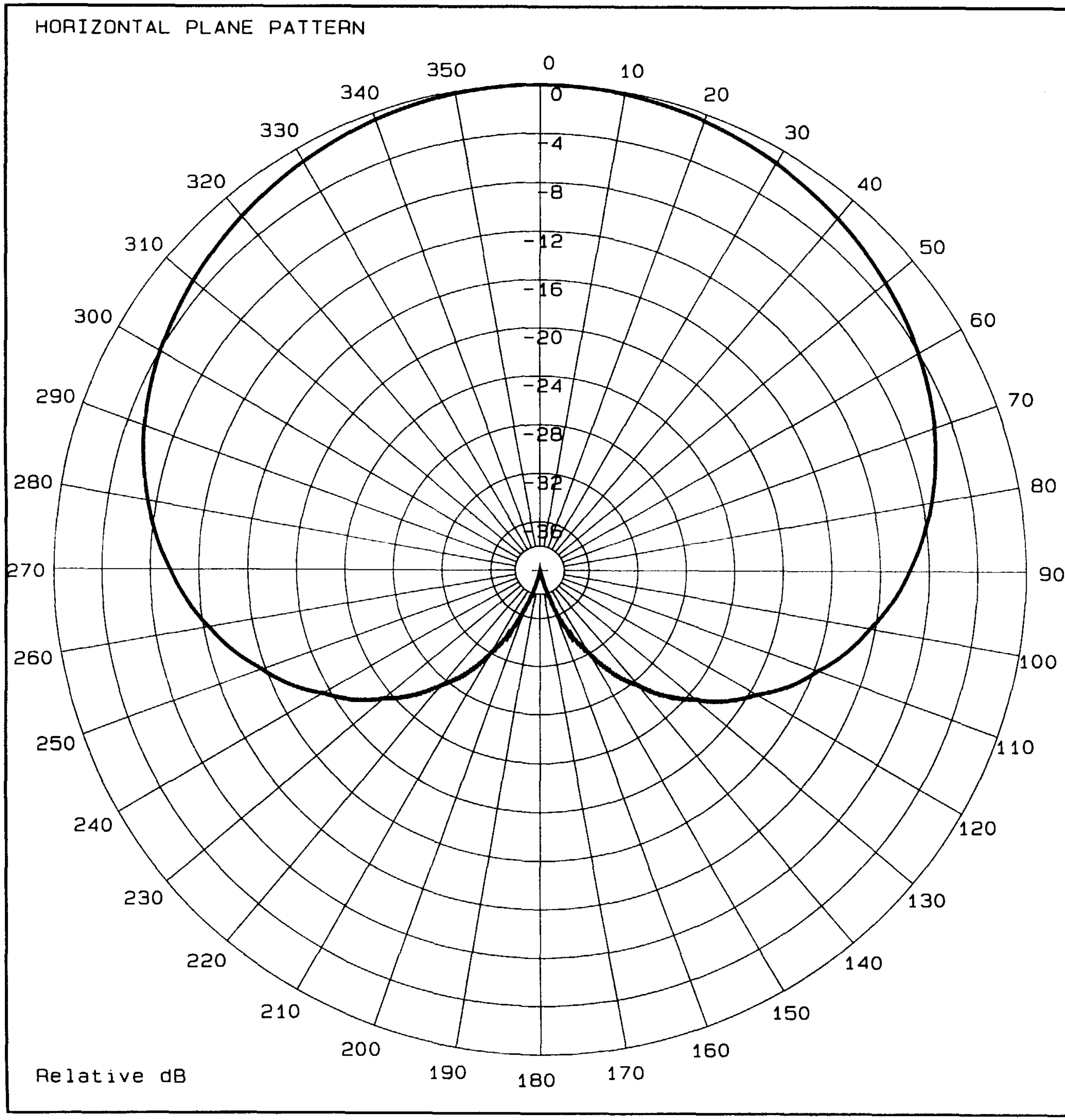
Exhibit 1 NORTHPONT TRANSMIT ANT PATTERN

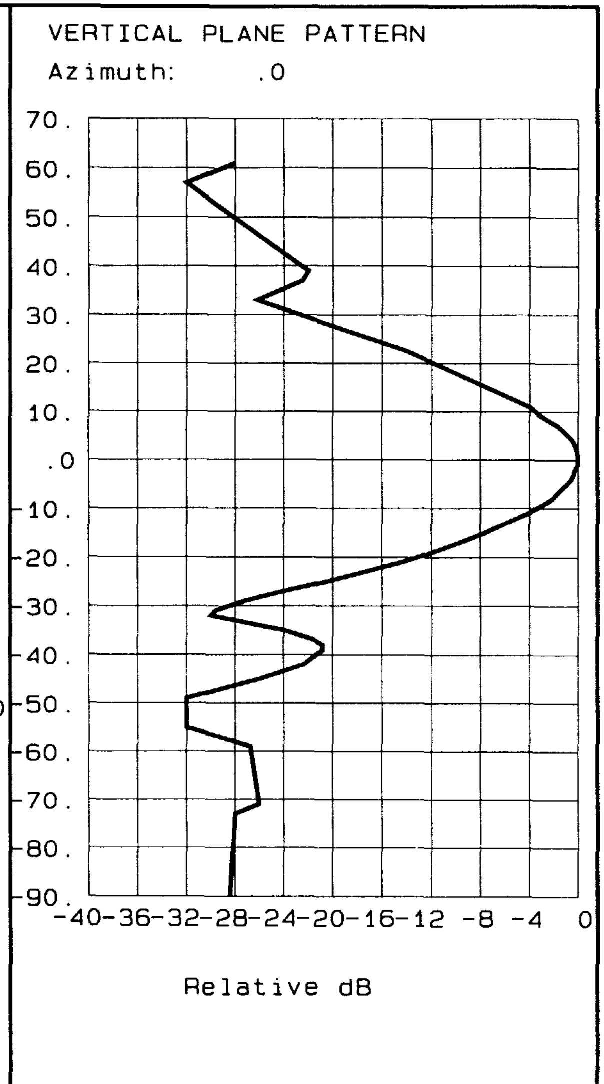
Total Northpoint Service Area: 240.0. sq. km.
Northpoint Transmitter Location: Austin, TX

MITIGATION AREAS (for C/I of 20 dB)

Exhibit	DBS Rec. Antenna Satellite	Northpoint Rad. Center (m AGL)	Northpoint mech. BT (°down @ AZ)	Exclusion Zone Area (sq. km)	Exclusion Zone Area Percentage (% of Serv.)
2	61.5	0	0 @ 0.0°	1.6	0.67
3	61.5	100	0 @ 0.0°	1.2	0.50
4	61.5	150	0 @ 0.0°	0.8	0.33
5	61.5	150	3 @ 0.0°	0.4	0.17
6	61.5	150	5 @ 0.0°	<0.1	<0.04
7	61.5	200	0 @ 0.0°	0.4	0.17
8	61.5	200	3 @ 0.0°	<0.1	<0.04
9	61.5	200	5 @ 0.0°	<0.1	<0.04
10	101	150	0 @ 0.0°	0.3	0.13
11	101	150	3 @ 0.0°	0.1	0.04
12	101	150	5 @ 0.0°	<0.1	<0.04
13	119	150	0 @ 0.0°	0.7	0.29
14	119	150	3 @ 0.0°	0.4	0.17
15	119	150	5 @ 0.0°	0.1	0.04

Exhibit 1

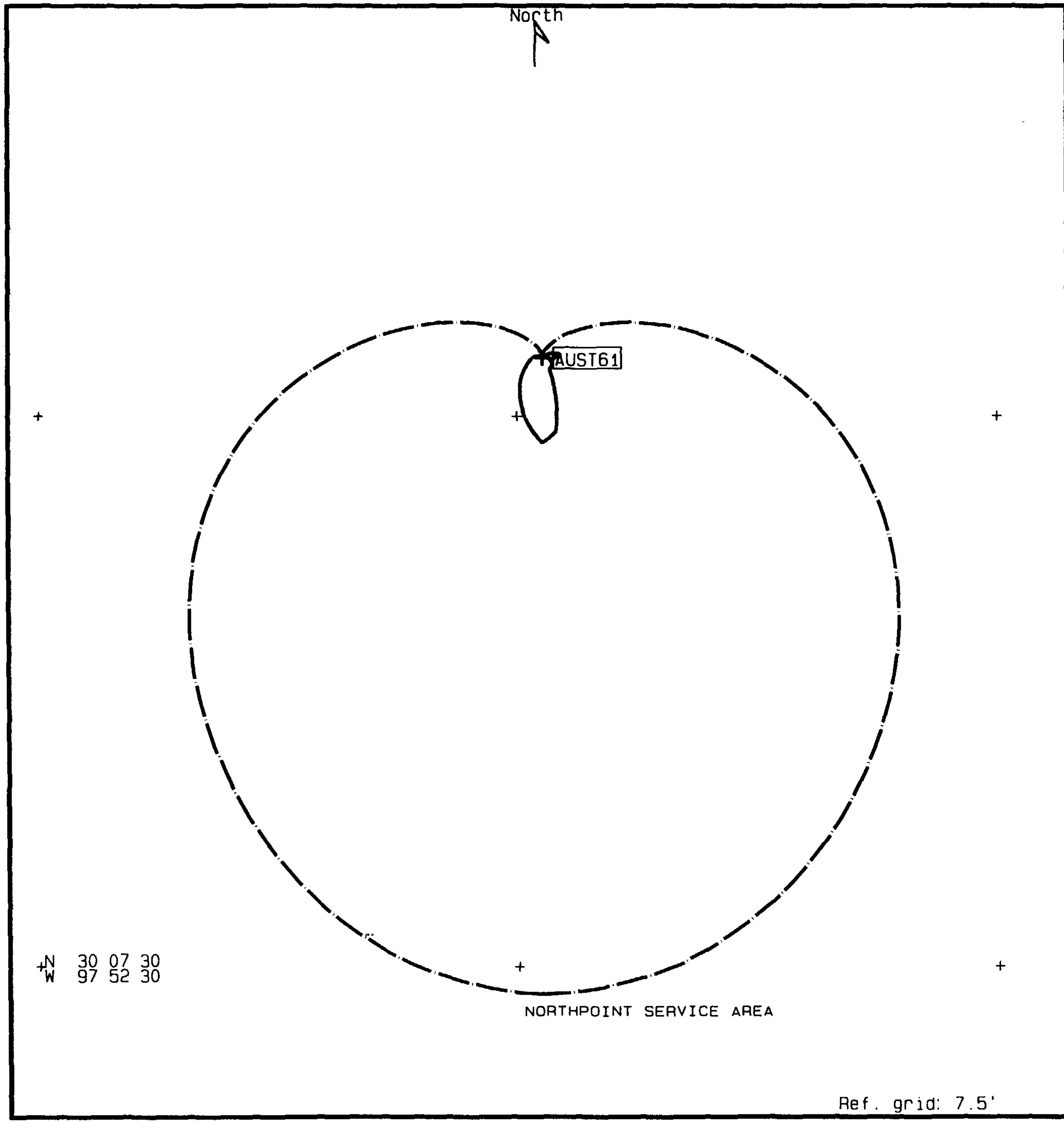




Pattern file: pat\aust.pat

Northpoint Transmit Antenna Pattern

Exhibit 2



MSITE (tm) : map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST61 *	144.2		DA-H	N 30 15 48.00
grp: 1	12500.0000 MHz		.0	W 97 44 36.00

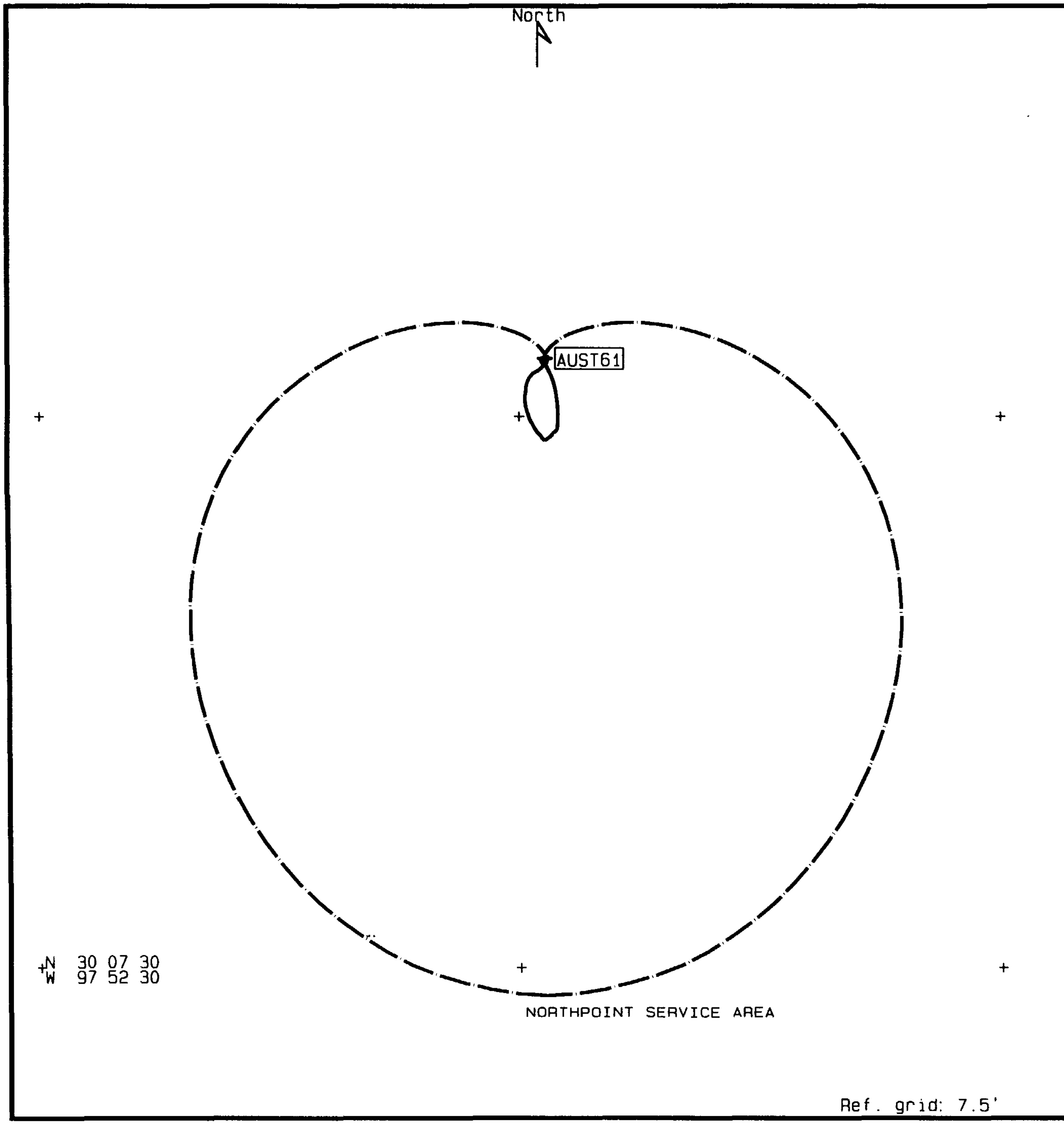
KILOMETERS
2 0 2 4 6 8

Austin and 61.5 SAT

20 dB C-to-I

RC: 0 m AGL MAP

Exhibit 3



MSITE(tm):map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST61	* 244.2		DA-H	N 30 15 48.00
grp: 1	12500.0000 MHz		.0	W 97 44 36.00

KILOMETERS
2 0 2 4 6 8

Austin and 61.5 SAT
20 dB C-to-I

RC: 100m AGL MAP